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**(54) RESIN COMPOSITION FOR REFLECTING PLATE**

(57) It is an object to provide a resin composition that is a suitable resin composition as a reflector plate and which can satisfy at a high level a variety of desired physical properties such as mechanical strength and heat resistance, dimensional stability, and further a light reflection and light-screening factors, and the like, as well as providing a molded article thereof. It is another object to provide a resin composition for reflector plates that can give a sufficient reflection factor and thus brightness, and at the same time satisfies the aforementioned desired physical properties even when it is used for a white LED apparatus fitted with an ultraviolet-ray emission device. A first aspect of the present invention relates to a resin composition for reflector plates charac-

terized by containing 30 to 95% by weight of a semi-aromatic polyamide having the ratio of aromatic monomers to all the monomer components being 20% by mole or more, and 5 to 70% by weight of potassium titanate fiber and/or wollastonite. Furthermore, a second aspect of the present invention relates to a resin composition for reflector plates used for an ultraviolet-ray generating source, characterized by comprising a thermoplastic resin and at least one inorganic compound selected from the group consisting of fibrous and flaky inorganic compounds capable of reflecting ultraviolet rays as well as visible light.

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**Description**

## TECHNICAL FIELD

- 5   **[0001]** The present invention relates to a resin composition for reflector plates that is suitably used for emission devices such as a light emission diode (hereafter, referred to as "LED").

## BACKGROUND ART

- 10   **[0002]** LEDs are emission apparatuses which are produced by mounting an emission device on a reflector plate (substrate) and sealing it with epoxy resin or the like, and that have a variety of preferred characteristics such as being readily incorporated into various instruments due to being small and lightweight, having a very long life on account of being strong against vibration and repetition of ON/OFF, and exhibiting clear coloring and particularly excellent visibility, as well as having a relatively small amount of electricity to be consumed. Of these LEDs, a white LED fitted with an  
15   ultraviolet light emitting device and a phosphor, which emits white light by ultraviolet rays generated by the ultraviolet light emitting device, has received great attention as light sources for a back light of a liquid crystal display screen for a cellular phone, a computer, a television and the like, a headlight of an automobile and an instrument panel, lighting equipment, and the like.

- 20   **[0003]** An LED reflector plate used for such emission apparatuses generally requires good reflection performance that reflects light or ultraviolet rays emitted by an emission device at a high efficiency. In addition, the LED reflector plate needs high dimensional precision because the LED reflector plate like an emission device is a fine part of from about 1 to about 2 mm, and also needs an excellent mechanical strength on account of a possible decrease in reflection performance thereof even for a small distortion, and further a high heat resistance due to being exposed to a high temperature by means of soldering and the like.

- 25   **[0004]** Conventionally, the reflector plates of LEDs include, for example, a reflector plate made by applying plating and coating to a resin molded article. The reflector plate, while acceptably offering practical use in reflection performance, has disadvantages of being difficult to uniformly apply plating to the whole, tending to be deviated from dimensional precision, and having a high rate of defectives, on account of a very fine article as mentioned above. Furthermore, mechanical strength and heat resistance thereof, when considering a long life of an LED, is not sufficiently satisfied.

- 30   **[0005]** As such, there is proposed, for example, as a resin composition for reflector plates a resin composition produced by blending with fiberglass a melt processed polyester such as an aromatic polyester and an aromatic polyester amide and further, as appropriate, blending titanium oxide (Japanese Examined Patent Application Publication No. 06-38520). This resin composition is good in heat resistance and dimensional stability to some extent, but has disadvantages of being insufficient in the degree of whiteness, and being low in light reflection factor. According to the above  
35   publication, although potassium titanate fibers and wollastonite are cited as mixable inorganic fibers in addition to fiberglass as well, inorganic fibers thereof in combination with a melt processed polyester cannot obtain a sufficient light reflection factor.

- 40   **[0006]** Further, proposed are a resin composition containing therein 10 to 40% by weight of an aromatic polyester, 15 to 55% by weight of a polyamide, 15 to 45% by weight of a polycarbonate and 10 to 30% by weight of titanium oxide (Japanese Unexamined Patent Application Publication No. 59-113049), a resin composition made of 60 to 95% by weight of a polyamide (nylon 46) and 5 to 40% by weight of titanium oxide (Japanese Unexamined Patent Application Publication No. 02-288274), a resin composition made by blending matrix resin of a polyester and a polyamide with  
45   10 to 50% by weight of titanium oxide and 0.3 to 30% by weight of a modified polyolefin (Japanese Unexamined Patent Application Publication No. 03-84060), and the like. These resin compositions, however, provide the disadvantages of large molding shrinkage factor and linear expansion coefficient, and bad dimensional stability specifically on account of the linear expansion coefficient upon a high temperature load. Furthermore, they cannot sufficiently satisfy the light reflection factor and light-screening factor.

- 50   **[0007]** In other words, resin compositions for conventional reflector plates have a level of satisfying some physical properties that are needed as the reflector plate, but pose problems of the other physical properties being not capable of satisfaction.

**[0008]** Accordingly, taking into consideration the above-described conventional problems, it is an object of the present invention to provide a resin composition for reflector plates that satisfies desired, various physical properties at a high level and can be suitably used as a reflector plate.

- 55   **[0009]** Moreover, in addition to these problems, use of an LED fitted with an ultraviolet light emitting device cannot provide sufficient brightness even when any of the above-described LED reflector plates are used, leading to the problem of lowering visibility. Hence, as light sources of a back light of a liquid crystal display screen for a cellular phone, an instrument panel for an automobile, and the like, the LEDs fitted with the ultraviolet light emitting device are unsuitable. In addition, neither the mechanical strength nor the heat resistance of the reflector plates can reach a

sufficiently satisfactory level; the use of a long period of time results in possible distortion.

[0010] Conventionally, in order to primarily improve mechanical strength and heat resistance as well as flame resistance, Japanese Unexamined Patent Application Publication No. 07-242810 has proposed as a reflector plate a resin composition produced by blending a thermoplastic resin such as an aromatic polycarbonate with titanium oxide and potassium titanate fibers. Nonetheless, a reflector plate made of the material utilizes potassium titanate fibers for the purpose of mainly improving mechanical strength and heat resistance as well as flame resistance and essentially requires a combination with titanium oxide, and thus the application of the reflector plate to a white LED having an ultraviolet light emitting device leads to insufficient brightness and is incapable of avoiding a decrease in visibility.

[0011] In addition, Japanese Unexamined Patent Application Publication No. 62-179780 has disclosed a resin composition made by blending a melt processing polyester such as an aromatic polyester or an aromatic polyester amide with white dyes such as titanium oxide, zinc oxide, zinc sulfide, zinc sulfate and white lead, as reflector plate materials, and containing therein, as required, a filler such as potassium titanate fibers or fiberglass. However, the above publication neither specifically discloses a composition made by blending a polyester substantially only with potassium titanate fibers, nor suggests that the composition is extremely useful as a reflector plate for a LED equipped with an ultraviolet light emitting device and a phosphor, which emits light by ultraviolet rays generated by the ultraviolet light emitting device.

[0012] On the other hand, a resin composition produced by blending a thermoplastic resin with potassium titanate fibers and the like is well known besides the above-described publications, and is used as materials of housing, mechanism parts, sliding parts and the like of electrical and electronic articles, precision machinery, and other machinery. Also, the purpose for blending potassium titanate and the like is only to improve the mechanical strength.

[0013] That is, in prior art, neither use of a composition made by blending a thermoplastic resin solely with potassium titanate fibers is carried out as a reflector material for an ultraviolet-ray source, nor special effects obtained thereby are known at all.

[0014] Thus, it is another object of the present invention to provide a resin composition for reflector plates that obtains a sufficient reflection factor and thus brightness, and which at the same time satisfies the above-described desired physical properties, even when a composition is employed for a white LED apparatus fitted with an ultraviolet-ray emission device.

#### DISCLOSURE OF THE INVENTION

[0015] The present inventor, as a result of earnest studies to achieve the first above-described object, has successfully obtained a resin composition suited to material for reflector plates, thus accomplishing the present invention.

[0016] Namely, a first aspect of the present invention relates to a resin composition for reflector plates characterized by containing 30 to 95% by weight of a semi-aromatic polyamide having the ratio of aromatic monomers to all the monomer components being 20% by mole or more, and 5 to 70% by weight of potassium titanate fiber and/or wollastonite.

[0017] In accordance with the first aspect of the present invention, there can be provided a resin composition, produced by blending therein specified inorganic fibers, which do not spoil useful physical properties the semi-aromatic polyamide has, which satisfy at a high level desired physical properties such as the light reflection factor, whiteness, molding processability, mechanical strength, dimensional stability, heat resistance and hygroscopicity, and particularly which are excellent in light screening and capable of maintaining a high whiteness without discoloring even though exposed to a high temperature.

[0018] While it is known that blending of a synthetic resin with inorganic fibers improves mechanical strength, dimensional stability, heat resistance and the like, the present invention produces these effects as well as further, by a combination of the aforementioned semi-aromatic polyamide, potassium titanate fibers and wollastonite, particularly bringing about the excellent effect of light screening being remarkably high.

[0019] A resin composition having the excellent physical properties such as stated above of the present invention is useful as a reflector plate material, especially as an LED reflector plate material.

[0020] Furthermore, the present inventor, to achieve the second above-described object, has found a novel reflector plate material capable of obtaining a high brightness even when the material is used for a white LED equipped with an ultraviolet-ray emission device, thus accomplishing the present invention.

[0021] In other words, a second aspect of the present invention relates to a resin composition for reflector plates used for an ultraviolet-ray generating source, which is characterized in that the resin composition comprises a thermoplastic resin and at least one inorganic compound selected from the group consisting of fibrous and flaky inorganic compounds capable of reflecting ultraviolet rays as well as visible light.

[0022] According to studies of the present inventors, the use of a reflector plate made of a material produced by blending in a thermoplastic resin at least one inorganic compound selected from the group consisting of fibrous and flaky inorganic compounds capable of reflecting ultraviolet rays as well as visible light can transmit to a phosphor in a

high density ultraviolet rays generated by an ultraviolet light emitting device, and so it has been found out that generated light of an LED using an ultraviolet light emitting device, especially a white LED, can be made an extremely high brightness and remarkably good visibility. On the contrary, a conventionally widely used reflector plate made of a resin composition containing titanium oxide reflects visible light, but absorbs ultraviolet rays of 420 nm or less, and thus it is estimated that the brightness of generated light is not sufficiently high.

[0023] In addition, a resin composition relating to the second aspect of the present invention satisfies at a high level a variety of characteristics such as molding processability, mechanical strength, dimensional stability, heat resistance, hygroscopicity, and the like, and therefore does not lose a long life of a LED.

[0024] Now, a resin composition of the second aspect of the present invention can be suitably utilized as reflector plates for various ultraviolet-ray generating sources, specifically for different LEDs fitted with an ultraviolet light emitting device and a phosphor, which emits light by ultraviolet rays. Of these, the resin composition is more suitably used for a white LED.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

Figure 1 is a graph indicating the relationship between the wavelength of light and the reflection factor, of the resin composition (Example 9) according to a second aspect of the present invention.

Figure 2 is a graph indicating the relationship between the wavelength of light and the reflection factor, of the resin composition (Example 10) according to the second aspect of the present invention.

Figure 3 is a graph indicating the relationship between the wavelength of light and the reflection factor, of the resin composition (Example 11) according to the second aspect of the present invention.

Figure 4 is a graph indicating the relationship between the wavelength of light and the reflection factor, of the resin composition (Example 12) according to the second aspect of the present invention.

Figure 5 is a graph indicating the relationship between the wavelength of light and the reflection factor, of the conventional resin composition (Comparative Example 7).

Figure 6 is a graph indicating the relationship between the wavelength of light and the reflection factor, of the conventional resin composition (Comparative Example 8).

Figure 7 is a graph indicating the relationship between the wavelength of light and the reflection factor, of the conventional resin composition (Comparative Example 9).

Figure 8 is a graph indicating the relationship between the wavelength of light and the reflection factor, of the conventional resin composition (Comparative Example 10).

#### BEST MODE FOR CARRYING OUT THE INVENTION

[0026] In the first aspect of the present invention, the semi-aromatic polyamides stand for polyamides containing therein aromatic monomers as monomer components of a polyamide. For a semi-aromatic polyamide used as a matrix, the aromatic monomers in the monomer components constituting the semi-aromatic polyamide are 20% by mole or more, preferably 25% by mole, more preferably from 30 to 60% by mole; the melting point of the semi-aromatic polyamide is preferably 280°C or more, more preferably from 280 to 320°C. Here, the molar fractions of the monomers in an aromatic polyamide can be adjusted by setting the ratios of the monomers in polymer material to be specified molar fractions.

[0027] The aromatic monomers include, for example, aromatic diamines, aromatic dicarboxylic acids, aromatic aminocarboxylic acids and the like. The aromatic diamines include, for example, p-phenylenediamine, o-phenylenediamine, m-phenylenediamine, paraxylenediamine, metaxylenediamine and the like. The aromatic dicarboxylic acids include, for example, terephthalic acid, isophthalic acid, phthalic acid, 2-methylterephthalic acid, naphthalene dicarboxylic acid and the like. Also, the aromatic aminocarboxylic acids include, for example, p-aminobenzoic acid and the like. Of these, aromatic dicarboxylic acids are preferable. The aromatic monomers can be used solely or in combination of two or more thereof.

[0028] The monomer components exclusive of the aromatic monomers include aliphatic dicarboxylic acids, aliphatic alkylenediamines, alicyclic alkylenediamines, aliphatic aminocarboxylic acids and the like.

[0029] The aliphatic dicarboxylic acids include adipic acid, sebacic acid, azelaic acid, dodecanedionic acid and the like. Of these, adipic acid is preferable. The aliphatic dicarboxylic acids can be used solely or in combination of two or more thereof.

[0030] The aliphatic alkylenediamines may be of straight chains or of branched chains. More specifically, the aliphatic alkylenediamines include ethylenediamine, trimethylenediamine, tetramethylenediamine, pentamethylenediamine, hexamethylenediamine, 1,7-diaminoheptane, 1,8-diaminooctane, 1,9-diaminononane, 1,10-diaminodecane, 2-methylpen-

tamethylenediamine, 2-ethyltetramethylenediamine and the like. Of these, hexamethylenediamine, 2-methylpentamethylenediamine and the like are preferable. The aliphatic alkylenediamines can be used solely or in combination of two or more thereof.

[0031] The alicyclic alkylenediamines include, for example, 1,3-diaminocyclohexane, 1,4-diaminocyclohexane, 1,3-bis(aminomethyl)cyclohexane, bis(aminomethyl)cyclohexane, bis(4-aminocyclohexyl)methane, 4,4'-diamino-3,3'-dimethyldicyclohexylmethane, isophoronediamine, piperazine and the like. The alicyclic alkylenediamines can be used solely or in combination of two or more thereof.

[0032] The aliphatic aminocarboxylic acids can include, for example, 6-aminocaproic acid, 11-aminoundecanoic acid, 12-aminododecanoic acid and the like; cyclic lactams corresponding to these may be used. The aliphatic aminocarboxylic acids can be used solely or in combination of two or more thereof.

[0033] Of these monomer components, aliphatic dicarboxylic acids, aliphatic alkylenediamines and the like are preferable. These monomer components can be used solely or in combination of two or more thereof.

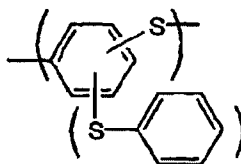
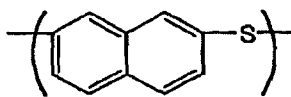
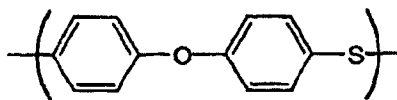
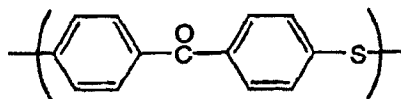
[0034] Of the aforementioned semi-aromatic polyamides, those containing an aromatic dicarboxylic acid and an aliphatic alkylenediamine, those containing an aromatic dicarboxylic acid, an aliphatic dicarboxylic acid, an aliphatic alkylenediamine and the like are preferable.

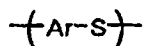
[0035] Furthermore, even of these semi-aromatic polyamides, the dicarboxylic acids comprising terephthalic acid, and comprising a mixture of terephthalic acid and isophthalic acid, and comprising a mixture of terephthalic acid, isophthalic acid and adipic acid are preferable. In the two aforementioned mixtures, a mixture having a ratio of terephthalic acid being 40% by mole or more is particularly preferable. In addition, even of these semi-aromatic polyamides, the aliphatic alkylenediamines comprising hexamethylenediamine and comprising a mixture of hexamethylenediamine and 2-methylpentamethylenediamine are particularly preferable.

[0036] Of the semi-aromatic polyamides, as a particularly preferred example, it can be cited a copolymer produced by copolymerizing 50% by mole of terephthalic acid, 25% by mole of hexamethylenediamine and 25% by mole of 2-methylpentamethylenediamine.

[0037] The appropriate selection of the composition ratios and kinds of aromatic monomer and other monomer components constituting the semi-aromatic polyamides can adjust, as required, melting points, glass transition temperatures and the like.

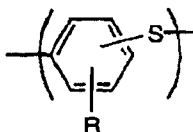
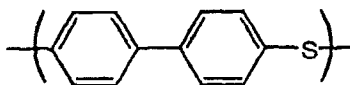
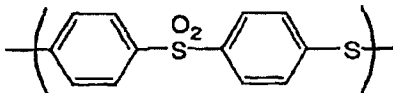
[0038] Additionally, the first aspect of the present invention may use a polyphenylene sulfide along with a semi-aromatic polyamide as a matrix resin of a resin composition. As the polyphenylenesulfides, well known ones all can be used, and linear and crosslinked structures all may be used. For example, crystalline polymers are included that contain as composition elements the repeat units denoted by general formulas below:





[wherein Ar represents a 1,4-phenylene group, a 1,3-phenylene group, or a 1,2-phenylene group.]

**[0039]** These polyphenylenesulfides desirably include those containing the aforementioned repeat units as the main components and thus those containing the aforementioned repeat units alone, preferably those containing 80% by mole or more of the repeat units, more preferably those containing 90% by mole of the repeat units. In a case where the substantial total amounts of polyphenylenesulfides are not composed of the aforementioned repeat units, the balances can be supplemented with copolymerizable repeat units, for example, the repeat units below:



[wherein R is an alkyl group, an alkoxy group, a nitro group or a phenylene group.]

**[0040]** In addition, as polyphenylenesulfides, commercially available articles may be employed. The commercially available articles include, for example, Tohpren (trade name, product of Tohpren Co., Ltd.), Rytan (trade name, product of Toray Industries Inc.), Fortron (trade name, product of Polyplastics Co., Ltd.) and the like.

**[0041]** In the first aspect of the present invention, the amount of blending of a matrix resin component, including cases where the resin component comprises a semi-aromatic polyamide alone and comprises a combination of a semi-aromatic polyamide and a polyphenylenesulfide, is from 30 to 95% by weight based on the total amount of resin composition, preferably from 30 to 90% by weight, more preferably from 40 to 70% by weight. As the amount of blending of the resin components deviates from the range of 30 to 95% by weight, a resin composition cannot sometimes be obtained that satisfies at a high level a variety of physical properties necessary for a reflector plate.

**[0042]** Also, in a case where a semi-aromatic polyamide and a polyphenylenesulfide are used together, although the blending ratios of these resins can be, as appropriate, selected, the semi-aromatic polyamide may be blended so as to be preferably from 40 to 90% by weight based on the total amount of these resins, more preferably from 50 to 80% by weight.

**[0043]** In the first aspect of the present invention, as inorganic fibers blended with a mixture of a semi-aromatic polyamide or the aromatic polyamide and a polyphenylenesulfide, potassium titanate fibers and/or wollastonite is used.

**[0044]** Potassium titanate fibers are not particularly limited, and conventionally well-known ones are widely used. Examples capable of use include 4 potassium titanate fibers, 6 potassium titanate fibers, 8 potassium titanate fibers, and the like. The size of potassium titanate fibers is not particularly restricted, but normally an average fiber diameter is from 0.01 to 1  $\mu\text{m}$ , preferably from 0.1 to 0.5  $\mu\text{m}$ ; an average fiber length is from 1 to 50  $\mu\text{m}$ , preferably from 3 to 30  $\mu\text{m}$ . In the present invention, commercial articles are usable as well and, for example, TISMO (trade name, product of Otsuka Chemical Co., Ltd., average fiber diameter: 0.2 to 0.5  $\mu\text{m}$ , average fiber length: 5 to 30  $\mu\text{m}$ ) and the like can be used.

**[0045]** Wollastonite is an inorganic fiber of calcium metasilicate. The size of wollastonite is not particularly limited, but normally an average fiber diameter is from 0.1 to 15  $\mu\text{m}$ , preferably from 2.0 to 7.0  $\mu\text{m}$ ; an average fiber length is from 3 to 180  $\mu\text{m}$ , preferably from 20 to 100  $\mu\text{m}$ . An average aspect ratio is 3 or more, preferably from 3 to 50, more preferably from 5 to 30.

**[0046]** Wollastonite can suitably use commercially available articles, for example, including Baistal K101 (trade name, product of Otsuka Chemical Co., Ltd., average fiber diameter: 2 to 5  $\mu\text{m}$ , average fiber length: 5 to 30  $\mu\text{m}$ ), Nyglosl-

10013 (trade name, product of Nyco Corp., average fiber diameter: 5 to 30  $\mu\text{m}$ , average fiber length: 5 to 30  $\mu\text{m}$ ), and the like.

[0047] Of these, taking into account the light-screening factor and the whiteness of an obtained resin composition, potassium titanate fiber is preferable.

[0048] In the first aspect of the present invention, in order to further improve physical properties such as mechanical strength of a resultant resin composition, potassium titanate fiber and wollastonite may be surface treated. Surface treatment follows a well-known process, and can be carried out using a silane coupling agent, a titanium coupling agent, or the like. Of these, a silane coupling agent is preferable and aminosilane is particularly preferable.

[0049] The amount of blending of potassium titanate fiber and/or wollastonite is normally from 5 to 70% by weight based on the total amount of resin composition, preferably from 10 to 70% by weight (resin component: 30 to 90% by weight), more preferably from 20 to 60% by weight (resin component: 40 to 80% by weight). As the amount deviates from the range of 5 to 70% by weight, a resin composition that satisfies at a high level various physical properties required for a reflector plate cannot be obtained in some cases.

[0050] Furthermore, in the first aspect of the present invention, within the range of not spoiling preferred, various physical properties of a resin composition, particularly in order to further improve the light reflection factor, the light-screening factor and the like, titanium oxide may be blended. In particular, when wollastonite is used as an inorganic fiber, it is preferable to use it in combination with titanium oxide. Titanium oxide is not particularly limited, and a variety of crystalline forms such as the anatase type, the rutile type, and the monoclinic type all can be employed. Although different crystalline forms can be used in combination of two or more types, the rutile type is preferable that has a high refractive index and is good in light stability. Also, the shape of titanium oxide is particularly unlimited as well, diverse shapes such as a particle shape, a fiber shape, and a plate shape (including a flake shape, a scale shape, a mica shape, and the like) all can be used, and different shapes can also be used in combination of two or more shapes. While the size of titanium oxide is not particularly restricted, an average size thereof is preferably from 0.1 to 0.3  $\mu\text{m}$  in particle diameter. In addition, those that are treated with various surface treatment agents may be used. The amount of blending of titanium oxide is not particularly limited, it is, as appropriate, selected within the range of improving reflection efficiency as well as not losing preferred physical properties of a resin composition. However, normally, the amount of blending can be from about 1 to about 40% by weight (resin component: 30 to 94% by weight, potassium titanate fiber and/or wollastonite: 5 to 69% by weight) based on the total amount of resin composition, preferably from about 5 to about 30% by weight (resin component: 30 to 90% by weight, potassium titanate fiber and/or wollastonite: 5 to 65% by weight).

[0051] A resin composition concerning the first aspect of the present invention, within the range of not spoiling preferred physical properties thereof, may be blended with a well-known inorganic fiber exclusive of potassium titanate fiber and wollastonite. The inorganic fibers are not particularly limited, for example, being capable of including zinc oxide fiber, sodium titanate fiber, aluminum borate fiber, magnesium borate fiber, magnesium oxide fiber, aluminum silicate fiber, silicon nitride fiber, and the like.

[0052] Moreover, a resin composition relating to the first aspect of the present invention, within the range of not damaging preferred physical properties thereof, may be blended with an antioxidant, a heat stabilizer and the like.

[0053] The antioxidants include a phenol-based antioxidant, a phosphorus-based antioxidant, a sulfur-based antioxidant and the like.

[0054] The phenol-based antioxidants include, for example, triethylene glycol bis[3-(3-*t*-butyl-5-methyl-4-hydroxyphenyl) propionate], 1,6-hexanediol bis[3-(3,5-di-*t*-butyl-4-hydroxyphenyl) propionate], pentaerythrityl-tetrakis[3-(3,5-di-*t*-butyl-4-hydroxyphenyl) propionate], octadecyl-3-(3,5-di-*t*-butyl-4-hydroxyphenyl) propionate, 3,5-di-*t*-butyl-4-hydroxybenzylphosphonate-diethylester, *N,N'*-hexamethylenebis(3,5-di-*t*-butyl-4-hydroxy-hydroxycinnamide), 1,3,5-trimethyl-2,4,6-tris(3,5-di-*t*-butyl-4-hydroxybenzyl) benzene, 3,9-bis[2-(3-(3-*t*-butyl-4-hydroxy-5-methylphenyl) propionyloxy)-1,1-dimethylethyl]-2,4,8,10-tetraoxaspiro[5,5] undecane, and the like. Of these, pentaerythrityl-tetrakis(3-(3,5-di-*t*-butyl-4-hydroxyphenyl) propionate), *N,N'*-hexamethylenebis(3,5-di-*t*-butyl-4-hydroxy-hydroxycinnamide) are preferable.

[0055] Examples of the phosphorus-based antioxidants include, for example, tris(2,4-di-*t*-butylphenyl) phosphite, 2-[[2,4,8,10-tetrakis(1,1-dimethylethyl)dibenzo[d,f][1,3,2]dioxaphosphin6-yl]oxy]-*N,N*-bis[2-[[2,4,8,10-tetrakis(1,1-dimethylethyl)dibenzo[d,f][1,3,2]dioxaphosphin6-yl]oxy]-ethyl]ethanamin, bis(2,6-di-*t*-butyl-4-methylphenyl) pentaerythritol diphosphate, and the like. Of these, 2-[[2,4,8,10-tetrakis(1,1-dimethylethyl)dibenzo[d,f][1,3,2]dioxaphosphin6-yl]oxy]-*N,N*-bis[2-[[2,4,8,10-tetrakis(1,1-dimethylethyl)dibenzo[d,f][1,3,2]dioxaphosphin6-yl]oxy]-ethyl]ethanamin is preferable.

[0056] Examples of the sulfur-based antioxidants include, for example, 2,2-thio-diethlenebis[3-(3,5-di-*t*-butyl-4-hydroxyphenyl)propionate], tetrakis[methylene-3-(dodecylthio)propionate]methane, and the like.

[0057] These antioxidants can be used solely or in combination of two or more thereof.

[0058] Furthermore, a resin composition according to the first aspect of the present invention, within the range of not damaging preferred physical properties thereof, can be blended with one, or two or more of a variety of additives

that have been used for synthetic resins as usual. The additives include, for example, inorganic fillers such as talc, silica, and zinc oxide (including a tetrapod shape), a fire retardant, a plasticizer, a nucleating agent, a pigment, a dye, a releasing agent, an ultraviolet absorber, and the like.

**[0059]** A resin composition of the first aspect of the present invention can be produced by melting and blending an aromatic polyamide with wollastonite and/or potassium titanate fiber and further, as required, other additives in accordance with a well-known process. Melting and blending can utilize all well-known melting and blending apparatuses such as a twin screw extruder.

**[0060]** A resin composition of the first aspect of the present invention can be molded to give a molded article (i.e., reflector plate) suitable for a variety of applications by means of a well-known resin molding process such as the injection molding process, the compression molding process, the extrusion process, or the like.

**[0061]** A reflector plate thus obtained can suitably be used, for example, as a reflector plate for emission apparatuses including emission apparatuses and the like used for various electrical and electronic parts, a keyless entry system of an automobile, lighting in a refrigerator, a back light of a liquid crystal display apparatus, an automobile front panel lighting apparatus, a desk lamp, a headlight, a household electrical appliance indicators, optical communication instruments such as an infrared communication apparatus, a ceiling illumination apparatus, outdoor display apparatuses such as a traffic sign, and the like.

**[0062]** On the other hand, a resin composition for reflector plates of the second aspect of the present invention has as the essential components a thermoplastic resin and at least one inorganic compound selected from the group consisting of fibrous and flaky inorganic compounds capable of reflecting ultraviolet rays as well as visible light.

**[0063]** The thermoplastic resins can use all well-known ones, for example, being able to include a semi-aromatic polyamide, an aliphatic polyamide, a polyester, polyethylene terephthalate, polypropylene terephthalate, polybutylene terephthalate, polyethylene naphthalate, a liquid crystalline polymer, polyethylene, a chlorinated polyethylene, polypropylene, polyisoprene, polybutadiene, polyvinyl chloride, polyvinylidene fluoride, polytetrafluoroethylene, polyacetal, polycarbonate, acryl resin, polystyrene, an impact-resistant polystyrene, syndiotactic polystyrene, acrylonitrile-styrene resin (AS resin), acrylonitrile-butadiene-styrene resin (ABS resin), methylmethacrylate-butadiene-styrene resin (MBS resin), methylmethacrylate-acrylonitrile-butadiene-styrene resin (MABS resin), acrylonitrile-acrylic rubber-styrene resin (AAS resin), polymethyl(meta)acrylate, polymethylpentene, polyphenylene ether (PPE), a modified polyphenylene ether, polyketone-based resins (polyether ketone, polyether ether ketone, polyether ketone ketone, polyether ether ketone ketone, and the like), polyethernitrile, polybenzimidazole, polyether sulfone, polysulfone, a thermoplastic polyimide, polyether imide, polyarylate, polyphenylene sulfide, polyphenylene oxide, polyamideimide, polyaromatic resin, and the like.

**[0064]** Of these, a thermoplastic resin that absorbs little visible light and/or a transparent thermoplastic resin is preferable, and further those that are high in solder heat resistance are preferable. The examples can include a semi-aromatic polyamide, an aliphatic polyamide, a liquid crystalline polymer, syndiotactic polystyrene, polybutylene terephthalate, polyethylene terephthalate, polyethylene naphthalate, polyacetal, polymethylpentene, and the like. Here, absorption of visible light being little specifically means that the appearance of the resin exhibits white even though dark or pale.

**[0065]** Of these resins, semi-aromatic polyamides (Japanese Unexamined Patent Application Publication Nos. 2001-279093, 2001-106908, 2000-273300, 2000-219809, 2000-186142, 2000-80270, 11-263840, 10-338746, 09-279020, 09-279018, 08-34850, 07-228694, 05-32870, etc.), a liquid crystalline polymer, syndiotactic polystyrene, and the like are particularly preferable.

**[0066]** In addition, the thermoplastic resins can be used solely or in combination of two or more thereof.

**[0067]** The amount of blending of a thermoplastic resin in a reflector plate material according to the second aspect of the present invention is not particularly limited, and may be selected, as required, from a wide range in accordance with various conditions such as the kind of thermoplastic resin itself, the kinds of combination-used visible and ultraviolet reflecting inorganic compounds, the kind of illuminant to which a resulting reflector plate is applied, and the like. However, taking into consideration the fact that the brightness of reflection light is further improved, the amount of blending is from 30 to 95% by weight based on the total amount of material of the present invention, preferably from 40 to 90% by weight.

**[0068]** In the second aspect of the present invention, fibrous and flaky inorganic compounds capable of reflecting ultraviolet rays as well as visible light stand for inorganic compounds capable of reflecting ultraviolet rays as well as visible light when being blended and dispersed in a thermoplastic resin. The inorganic compounds can use fibrous and/or flaky (plate-like) material, for example, including compounds containing potassium titanate and the like. A compound containing potassium titanate has characteristics of improving the mechanical strength and heat resistance of a thermoplastic resin to be a matrix and not losing the dimensional precision and molding processability.

**[0069]** The compounds containing potassium titanate can utilize all well-known compounds that contain potassium titanate and are fibrous or flaky. The examples can include potassium titanate fiber, flaky potassium titanate, flaky lithium potassium titanate, flaky potassium magnesium titanate, and the like.



[0070] The potassium titanate fibers can use those as for the above-described first aspect.

[0071] The flaky lithium potassium titanate is a well-known compound containing potassium titanate in which some of the potassium atoms of potassium titanate are replaced by lithium atoms. Examples are disclosed in Japanese Unexamined Patent Application Publication Nos. 03-285819, 2000-344520, etc.

5 [0072] The flaky potassium magnesium titanate is a well-known compound containing potassium titanate in which some of the potassium atoms of potassium titanate are replaced by magnesium atoms. Examples are disclosed in Japanese Unexamined Patent Application Publication Nos. 03-285819, 05-221795, 2000-230168, etc.

10 [0073] Further, a compound containing flaky potassium titanate of a hollandite structure expressed by a general formula  $K_xTi_8O_{16}$  ( $x = 1.0$  to  $2.0$ ) (Japanese Unexamined Patent Application Publication No. 62-105925), a compound containing flaky potassium titanate of a hollandite type structure expressed by a general formula  $(K_{x-y}H_y)Ti_8O_{16}$  ( $x = 1.0$  to  $1.3$ ,  $0 < y \leq 0.7$ ) (Japanese Unexamined Patent Application Publication No. 02-92822), etc. can also be used as compounds containing potassium titanate.

[0074] The fibrous and flaky inorganic compounds capable of reflecting ultraviolet rays as well as visible light can be used singly or in combination of two or more thereof.

15 [0075] Additionally, in the second aspect of the present invention, in order to further improve physical properties such as the mechanical strength of a reflector plate material obtained, surface treatment may be applied to a visible light and ultraviolet ray reflecting inorganic compound. Surface treatment may be conducted in accordance with a well-known process, and a silane coupling agent, a titanium coupling agent, and the like can be used. Of these, a silane coupling agent is preferable and aminosilane is particularly preferable.

20 [0076] The amount of blending of the fibrous and flaky inorganic compound capable of reflecting ultraviolet rays as well as visible light is not particularly limited, and may be selected, as required, from a wide range in accordance with various conditions such as the kind of combination-used thermoplastic resin, the kinds of visible and ultraviolet reflecting inorganic compounds themselves, the kind of illuminant to which a resulting reflector plate is applied, and the like. However, taking into consideration the fact that the brightness of reflection light is further improved, the amount of blending is normally from 5 to 70% by weight based on the total amount of resin composition according to the second embodiment of the present invention, preferably from 10 to 60% by weight.

25 [0077] A resin composition for reflector plates according to the second aspect of the present invention, within the range of not spoiling preferred characteristics thereof, can be blended with the antioxidant, heat stabilizer and the like as described above.

30 [0078] A resin composition for reflector plates according to the second aspect of the present invention, within the range of not spoiling preferred characteristics thereof, can be further blended with one, or two or more of a variety of additives conventionally used for synthetic resins. The additives can include, for example, fibrous inorganic fillers such as wollastonite and fiberglass, powdered inorganic fillers such as silica and talc, a dye, an antioxidant, an antistat, a mold release, a lubricant, a heat stabilizer, a drip inhibitor, a fire retardant, an ultraviolet absorber, a light stabilizer, a light-screening agent, a metal inactivating agent, an age resistor, a plasticizer, an impact strength improving agent, a compatibilizing agent, a viscosity controlling agent, an anti-foaming agent, a leveling agent, an organic solvent, and the like.

[0079] This additive is preferably set to be in a proportion of less than 10% by weight based on the total amount of ingredients of resin.

40 [0080] A resin composition for reflector plates according to the second aspect of the present invention can be produced by blending or kneading a synthetic resin, an inorganic compound capable of reflecting ultraviolet rays as well as visible light, and further, as necessary, other additives by means of well-known means. For example, pellets of a resin compositions of reflector plates concerning the second aspect of the present invention can be manufactured by blending or kneading powder, beads, flakes or each ingredient of pellet shapes using a kneader and the like such as an extruder such as a single extruder or a twin extruder, a Banbury mixer, a pressurizing kneader, a twin roll, and the like.

45 [0081] Also, a resin composition for reflector plates according to the second aspect of the present invention is formed via a well-known resin molding process such as the injection molding process, the compression molding process, or the extrusion process to be able to make a reflector plate of an arbitrary shape.

50 [0082] Reflector plates comprising a resin composition of the second aspect of the present invention is useful for reflector plates of emission apparatuses equipped with a variety of ultraviolet ray sources. The optical sources can include, for example, an LED fitted with an ultraviolet light emitting device and a phosphor that produces color by receiving ultraviolet rays, an ultraviolet lamp, a mercury lamp, a cold-cathode tube, a fluorescent lamp, an incandescent lamp, and the like. Furthermore, they are applied to illumination apparatuses with the emission apparatus and the like as well. Of these, the reflector plate is useful for an LED, particularly for a white LED.

55 [0083] In addition, an ultraviolet ray generating source having a reflector plate comprising a resin composition of the second aspect of the present invention can be used for applications as for conventional ultraviolet ray generating sources. Examples of the applications include:

communication applications such as LANs, facsimile, fiber communication and the like;  
 advertisement and information applications such as interior and exterior display plates, cubic displays, accessories,  
 and the like;  
 measurement and control applications such as vending machines, automatic doors, diverse sensors, light sources  
 for color measurement, and the like;  
 automobile applications such as meters within interior panels, indicators, high mounting stop lamps, tail lamps,  
 marker lights, and the like;  
 office appliance and OA applications such as electronic photo light sources, CD reading light sources, printers,  
 scanners, and the like;  
 traffic and transportation applications: vehicle light devices, signal signs, and the like.  
 crime prevention and disaster protection applications such as emergency lights, smoke detectors, gas leak detec-  
 tors, and the like;  
 forestry and fishery applications: light traps, fishing lures, growth promoting light sources, and the like;  
 medical applications such as medical testing instruments, support systems, sterilizing apparatuses, and the like;  
 household appliance applications such as VTRs, DVDs, stereos, televisions, air conditioners, indicators of house-  
 hold appliances, level meters, and the like; and  
 back light optical sources of various liquid crystal display screens of personal computers, cellular phones, liquid  
 crystal televisions, and the like, etc.

As discussed above, according to a resin composition of the second aspect of the present invention, when a reflector  
 plate is used for an emission apparatus such as a white LED using ultraviolet rays as a light source, it can well reflect  
 visible light and ultraviolet rays, thus obtaining sufficient brightness.

(Examples)

**[0084]** First, resin compositions according to the first aspect of the present invention will specifically be set forth in  
 terms of Examples and Comparative Examples. Additionally, synthetic resins and inorganic fibers used in the present  
 Examples and the Comparative Examples are specified as follows:

[Synthetic resins]

**[0085]** Semi-aromatic polyamide A: a semi-aromatic polyamide (trade name "Amodel A4000", product of DuPont)  
 produced by polymerizing hexamethylenediamine, terephthalic acid and adipic acid, in the ratio of 50% by mole to 32%  
 by mole to 18% by mole, respectively.

**[0086]** Semi-aromatic polyamide B: a semi-aromatic polyamide (trade name "Zytel HTN501", product of DuPont,  
 melting point 305°C, glass transition temperature 125°C) produced by polymerizing 2-methylpentamethylenediamine,  
 hexamethylenediamine and terephthalic acid in the ratio of 25% by mole, 25% by mole and 50% by mole, respectively.

**[0087]** Polyphenylsulfide: (trade name "Ryton M2888", product of Toray Industries Inc., hereafter referred to as  
 "PPS").

**[0088]** Aromatic polyester: (trade name "VECTRA C950," product of Polyplastics Co., Ltd., hereafter referred to as  
 "LCP").

[Inorganic fibers]

**[0089]** Wollastonite: (trade name "Baistal K101," product of Otsuka Chemical Co., Ltd., average fiber diameter 2 to  
 5  $\mu\text{m}$ , average fiber length 20 to 30  $\mu\text{m}$ ).

**[0090]** Potassium titanate fiber: (trade name "TISMO D101," product of Otsuka Chemical Co., Ltd., average fiber  
 length 10 to 20  $\mu\text{m}$ , average fiber diameter 0.3 to 0.6  $\mu\text{m}$ ).

**[0091]** Powder titanium oxide: (trade name "JR-405," product of Tayca Corporation, average particle diameter 0.21  
 $\mu\text{m}$ ).

**[0092]** Chopped glass fiber: (trade name "ECS 03T 249/PL," product of Nippon Electric Glass Co., Ltd., hereafter  
 called "GF").

[Examples 1 to 8 and Comparative Examples 1 to 6]

**[0093]** In the blending ratios (% by weight) indicated in Table 5 below, pellets of a resin composition of the first aspect  
 of the present invention were produced by charging a semi-aromatic polyamide or a semi-aromatic polyamide and  
 PPS into the main hopper of a twin-screw kneading extruder, after melt kneading at 330°C, adding thereto potassium

titanate fiber or wollastonite and further titanium oxide from the side feeder, and then melt kneading and extruding the mixture.

[0094] The pellets thus obtained of a resin composition concerning the first aspect of the present invention were introduced into an injection molding machine (trade name "JS75," product of The Japan Steel Works, Ltd., cylinder temperature 330°C) equipped with a mold for making a JIS test piece (mold temperature 130°C) to conduct injection molding, thereby producing various JIS test pieces, with subjecting the test pieces to the following performance tests.

(1) Tensile strength and tensile break elongation: measured in accordance with JIS K7113.

(2) Bending strength and bending elastic modulus: measured in accordance with JIS K7271.

(3) Impact value by a IZOD with a notch: evaluated using No.1 test piece in accordance with JIS K7110.

(4) HDT (heat resistance test): Heat distortion temperature (HDT, °C) was measured according to JIS K7207 when a bending stress 1.82 MPa was applied.

(5) Coefficient of linear expansion: measured at 20 to 130°C using a TAM120 thermal machine analysis apparatus (trade name "SSC5200H Disk-station," product of Seiko Instruments Inc.). The pulling out direction was denoted by MD and the vertical direction thereof denoted by TD. In order to evaluate the index of anisotropy, the linear expansion coefficient ratio of TD to MD (TD/MD) was indicated.

(6) Flow rate (Q value): measured using a higher type flow tester on Examples 1 to 8 and Comparative Examples 1 to 4 at 330°C × 9.8 MPa, on Example 9 at 290°C × 9.8 MPa, and on Comparative Example 10 at 310°C × 9.8 MPa, each having a residual heat time of 360 seconds, an orris pore diameter of 1 mm and a thickness of 10 mm.

(7) Water absorption degree: measured in accordance with JIS K7209.

(8) Hunter whiteness: measured using a color difference meter from Nippon Denshoku Industries Co., Ltd. Also, the evaluations were denoted by ⊙ for whiteness of 93 or more, by ○ of less than 93 and 91 or more, by Δ of less than 91 and 89 or more, by × of less than 89 and 85 or more, and by ×× of 85 or less.

(9) Heat resistance discoloring test: The heat resistance discoloring test was carried out in an oven in air at 180°C × 2 hours and the whiteness was measured as in (8).

(10) Light ray transmission: A sample that was made a film of 100 μm thick with a vacuum pressing machine was measured by means of a recording spectrophotometer U-3000 model from Hitachi, Ltd. and transmittances thereof using 460 nm, 530 nm and 630 nm were recorded.

[0095] The evaluations were indicated with ⊙ for a transmittance of 0%, with ○ of below 3% and 0% or more, with Δ of below 5% and 3% or more, and with × of 5% or more.

[0096] These results are tabulated in Table 1.

TABLE 1

	Example								Comparative Example					
	1	2	3	4	5	6	7	8	1	2	3	4	5	6
Semi-aromatic polyamide A	50	50	50	35	—	—	—	—	50	35	—	—	—	—
Semi-aromatic polyamide B	—	—	—	—	50	50	50	35	—	15	50	35	—	—
PPS	—	—	—	15	—	—	—	15	—	—	—	15	50	—
LCP	—	—	—	—	—	—	—	—	—	—	—	—	—	50
Potassium titanate fiber	50	30	—	—	50	30	—	—	—	—	—	—	—	—
Wollastonite	—	—	30	30	—	—	30	30	—	—	—	—	30	30
GF	—	—	—	—	—	—	—	—	30	30	30	30	—	—
Titanium oxide	—	20	20	20	—	20	20	20	20	20	20	20	20	20
Tensile strength (MPa)	183	176	136	117	191	171	130	116	132	119	130	121	131	91
Tensile break elongation (%)	2.5	2.7	2.4	2.1	2.4	2.6	2.1	1.8	2.4	2	2.2	1.8	2.1	1.4
Bending strength (MPa)	339	257	217	161	331	278	236	166	195	149	200	155	174	141
Bending elastic modulus (GPa)	15.3	12.0	10.7	11.0	16.5	13.1	11.5	12.7	10.3	10.1	11	10.7	14.5	14.3
IZOD impact value (J/m)	49	45	39	35	42	48	39	34	47	40	45	39	37	20
HDT(°C)	285	281	280	270	250	245	245	242	285	275	250	248	232	223
Linear expansion coefficient ( $\times 10^{-5}/K$ )	MD	1.5	2.3	2.4	1.1	1.8	2.0	1.9	2.1	2.0	1.5	1.6	1.9	2.1
	TD	5.0	4.7	4.6	4.6	3.5	3.2	3.2	5.7	5.7	4.0	4.1	3.2	3.0
	TD/MD	3.3	2.0	1.8	1.9	3.2	1.6	1.7	2.7	2.9	2.7	2.6	1.7	1.4
Q value ( $\times 10^{-2} \text{ cm}^3$ )	2.4	1.2	1.1	4.9	9.6	8.2	8.1	14	0.5	2.9	5.5	9.2	15.3	3.2
Water absorption degree (%)	0.2	0.2	0.19	0.14	0.1	0.1	0.09	0.07	0.21	0.15	0.15	0.1	0.02	0.03
Hunter whiteness	○	○	◎	○	○	◎	◎	◎	△	△	○	○	× ×	× ×
After molding						◎	◎	◎					× ×	× ×
After heat					◎	◎	◎	◎	×	×	○	○	× ×	× ×
resistance discoloring test					◎	◎	◎	◎	△	△	△	△	◎	◎
Light ray transmission (%)	◎	◎	◎	◎	◎	◎	◎	◎	×	×	×	×	○	◎
(460nm)									△	△	△	△	◎	◎
(530nm)									×	×	×	×	○	◎
(630nm)									×	×	×	×	○	◎

[0097] Figure 1 shows that resin compositions of the first aspect of the present invention satisfy physical properties

the reflector plate requires at high levels for the mechanical strength, heat resistance, linear expansion coefficient (dimensional stability), flowability (molding processability), whiteness, heat resistance discoloring, and light ray transmission. In particular, the light ray transmission is greatly lowered as compared with those of Comparative Examples 1 to 4 using fiberglass. Further, also, because Comparative Examples 5 and 6 using other heat resistance resins such as PPS, LCP and the like are extremely inferior in whiteness due to the color order of base resins themselves, it is clear that compositions indicated in the present Examples are excellent as reflector plates.

**[0098]** Next, resin compositions of the second aspect of the present invention will specifically be described in terms of Examples and Comparative Examples. In addition, thermoplastic resins used in the present Examples and fibrous or flaky inorganic compounds capable of reflecting ultraviolet rays as well as visible light are specified as follows:

**[Thermoplastic resins]**

**[0099]** Semi-aromatic polyamide: a semi-aromatic polyamide (trade name "Zytel HTN501," product of DuPont, melting point 305°C, glass transition temperature 125°C) produced by polymerizing 2-methylpentamethylenediamine, hexamethylenediamine and terephthalic acid in the ratio of 25% by mole, 25% by mole and 50% by mole, respectively.

**[0100]** Liquid crystal polymer: (trade name "VECTRA C950RX," product of Polyplastics Co., Ltd.).

**[Inorganic fillers]**

**[0101]** Potassium titanate fiber: (trade name "TISMO D101," product of Otsuka Chemical Co., Ltd., fiber length 10 to 20  $\mu\text{m}$ , fiber diameter 0.3 to 0.6  $\mu\text{m}$ ).

**[0102]** Lithium potassium titanate: composition:  $\text{K}_{0.8}\text{Ti}_{1.73}\text{Li}_{0.27}\text{O}_4$ , maximum diameter 3 to 5  $\mu\text{m}$ , minimum diameter 3 to 50  $\mu\text{m}$ , thickness 0.5 to 2  $\mu\text{m}$ .

**[0103]** Potassium magnesium titanate: (trade name "TERRACESS PS," product of Otsuka Chemical Co., Ltd., maximum diameter 3 to 5  $\mu\text{m}$ , minimum diameter 3 to 5  $\mu\text{m}$ , thickness 0.5 to 2  $\mu\text{m}$ ).

**[0104]** Powder titanium oxide: rutile type titanium oxide (trade name "JR-405," product of Tayca Corporation, average particle diameter 0.21  $\mu\text{m}$ ).

**[0105]** Fiberglass: (trade name "Chopped Strand ECS03T249/PL," product of Denki Kagaku Kogyo K.K. average fiber length 3 mm, average fiber diameter 13  $\mu\text{m}$ ).

**[Examples 9 to 12 and Comparative Examples 7 to 10]**

**[0106]** Based on the blending ratios (% by weight) shown in Tables 2 and 3, pellets of reflector plate material of the present invention were produced by charging a thermoplastic resin into the main hopper of a twin-screw kneading extruder, after melt kneading, adding thereto an inorganic filler from the side feeder, and then melt kneading and extruding the mixture. In addition, the melt kneading temperatures of thermoplastic resins in a twin-screw kneading extruder were set to be 330°C for Examples 9 to 11 and Comparative Examples 7 to 9, and 310°C for Example 12 and Comparative Example 10.

**[0107]** The pellets thus obtained of resin compositions for reflector plates according to the second aspect of the present invention were charged into an injection molding machine (trade name: JS75, product of The Japan Steel Works, Ltd., cylinder temperature 330°C) fitted with a JIS test piece preparing mold (mold temperature 130°C = Examples 9 to 11 and Comparative Examples 7 to 9, mold temperature 120°C = Example 12 and Comparative Example 10) to carry out injection molding, thereby producing each kind of JIS test pieces, with subjecting the test pieces to the following performance test of (11) in addition to the above-described performance tests of (1) to (5) and (7) and (8).

**[0108]** Additionally, Examples 9 to 11 and Comparative Examples 7 to 9 were subjected to 130°C of the mold temperature and 330°C of the cylinder temperature of the injection molding machine, and Example 12 and Comparative Example 10 subjected to 120°C of the mold temperature and 310°C of the cylinder temperature of the injection molding machine.

**[0109]** The results are tabulated in Tables 2 and 3.

(11) Reflection factor: The pellets obtained in the Examples and the Comparative Examples were injection molded as for the above to produce test pieces of 90 mm  $\times$  50 mm  $\times$  3.2 mm. The 380 nm reflection factor (%) of this test piece was measured with a visible and ultraviolet spectrophotometer (product of Hitachi, Ltd., magnetic spectrophotometer U-3000 model). For reference magnesium oxide was used. From the measurements thus obtained, 60% or more of the reflection factor was decided to be  $\odot$ , 45% to less than 60% to be  $\bigcirc$ , 30% to less than 45% to be  $\Delta$ , 15% to less than 30% to be  $\times$ , and less than 15% to be  $\times\times$ .

**[0110]** Also, using the measuring method of the aforementioned reflection factor, the relationship between the wave-

length and the reflection factor, of light, was determined. The results are shown in Figs. 1 to 8. In Figs 1 to 8, the ordinate shows the reflection factor (%) of light and the abscissa the wavelength (nm) of light.

TABLE 2

[Example]	9	10	11	12
Semi-aromatic polyamide	70	70	70	
Liquid crystal polymer				70
Potassium titanate fiber	30			30
Potassium lithium titanate		30		
Magnesium potassium titanate			30	
Fiberglass				
Rutile type titanium oxide				
Tensile strength (MPa)	180	113	112	184
Tensile break elongation (%)	3.7	3.8	3.7	4.7
Bending strength (MPa)	270	152	148	204
Bending elastic modulus (GPa)	9.1	6.8	6.4	13.0
IZOD impact value (J/m)	38	34	35	160
HDT(°C)	253	228	223	228
Linear expansion coefficient ( $\times 10^{-5}/K$ )	MD	2.2	3.8	3.9
	TD	5.6	3.9	4.1
	TD/MD	2.5	1.0	1.1
Q value $\times 10^{-2}cm^3$	0.17	0.18	0.17	0.04
Hunter whiteness	⊙	○	⊙	○
Reflection factor (380 nm, %)	⊙	⊙	⊙	○

TABLE 3

[Comparative Example]	7	8	9	10
Semi-aromatic polyamide	70	70	70	
Liquid crystal polymer				70
Potassium titanate fiber		20		
Potassium lithium titanate				
Magnesium potassium titanate				
Fiberglass			20	20
Rutile type titanium oxide	30	10	10	10
Tensile strength (MPa)	80	132	123	101
Bending strength (MPa)	1.7	2.3	2.3	1.9
Tensile break elongation (%)	110	237	161	141
Bending elastic modulus (GPa)	3.2	8.7	7.1	10.3
IZOD impact value (J/m)	24	44	29	80
HDT(°C)	178	243	254	220

TABLE 3 (continued)

[Comparative Example]		7	8	9	10
Linear expansion coefficient ( $\times 10^{-5}/K$ )	MD	5.8	2.8	2.7	1.0
	TD	5.9	6.1	6.7	4.5
	TD/MD	1.0	2.2	2.5	4.5
Q value ( $\times 10^{-2}cm^3$ )		0.18	0.17	0.17	0.04
Hunter whiteness		⊙	⊙	⊙	○
Reflection factor (380 nm, %)		× ×	× ×	× ×	× ×

[0111] Tables 2 and 3 clearly indicate that resin compositions of reflector plates according to the second aspect of the present invention meet at a high level a variety of characteristics such as mechanical strength, dimensional stability, heat resistance, and hygroscopicity.

[0112] In addition, Figs. 1 to 8 show that resin compositions of reflector plates according to the second aspect of the present invention reflect ultraviolet rays, particularly ultraviolet rays of from 360 nm to 400 nm, at high efficiency (Figs. 1 to 4). More specifically, the reflector plate of Example 9 containing potassium titanate fiber is remarkably high in reflection factor of ultraviolet rays (Fig. 1), whereas the case (Comparative Example 7) only containing rutile type titanium oxide and the case (Comparative Example 8) containing both potassium titanate fiber and rutile type titanium oxide are insufficient in reflection factor of ultraviolet rays (Figs. 5 and 6), that is, the degrees of reflection of ultraviolet rays are clearly extraordinarily low.

[0113] These results have proved that a resin composition for reflector plates concerning the second aspect of the present invention efficiently reflects ultraviolet rays as well as visible light and is suitable material as a resin composition for reflector plates when an ultraviolet ray is a light source.

#### Claims

1. A resin composition for reflector plates **characterized by** containing 30 to 95% by weight of a semi-aromatic polyamide having the ratio of aromatic monomers to all the monomer components being 20% by mole or more, and 5 to 70% by weight of potassium titanate fiber and/or wollastonite.
2. A resin composition for reflector plates according to claim 1, in which  
said semi-aromatic polyamide comprises a semi-aromatic polyamide containing as monomer components an aromatic dicarboxylic acid and an aliphatic alkylenediamine.
3. A resin composition for reflector plates according to claim 2, in which  
said semi-aromatic polyamide comprises a semi-aromatic polyamide further containing as a monomer component an aliphatic dicarboxylic acid.
4. A resin composition for reflector plates used for an ultraviolet-ray generating source, **characterized by** comprising a thermoplastic resin and at least one inorganic compound selected from the group consisting of fibrous and flaky inorganic compounds capable of reflecting ultraviolet rays as well as visible light.
5. A resin composition for reflector plates according to claim 4, in which  
the fibrous and flaky inorganic compound capable of reflecting ultraviolet rays as well as visible light comprises a compound containing potassium titanate.
6. A resin composition for reflector plates according to claim 5, in which  
the compound containing potassium titanate comprises one, or two or more selected from the group consisting of potassium titanate fiber, flaky lithium potassium titanate, and flaky potassium magnesium titanate.
7. A resin composition for reflector plates according to any one of claims 4 to 6, in which  
the thermoplastic resin comprises one, or two or more selected from the group consisting of thermoplastic resins that absorb little visible light and/or transparent thermoplastic resins.

8. A resin composition for reflector plates according to claim 7, in which  
the thermoplastic resin that absorbs little visible light and/or the transparent thermoplastic resin comprises  
one, or two or more selected from the group consisting of semi-aromatic polyamides, aliphatic polyamides, liquid  
crystal polymers, syndiotactic polystyrene, polybutylene terephthalate, polyethylene terephthalate, polyethylene  
naphthalate, polymethylpentene, and polyacetal.

9. A resin composition for reflector plates according to any one of claims 4 to 8, comprising 30 to 95% by weight of  
a thermoplastic resin and 5 to 70% by weight of an inorganic compound capable of reflecting ultraviolet rays as  
well as visible light.



FIG. 1

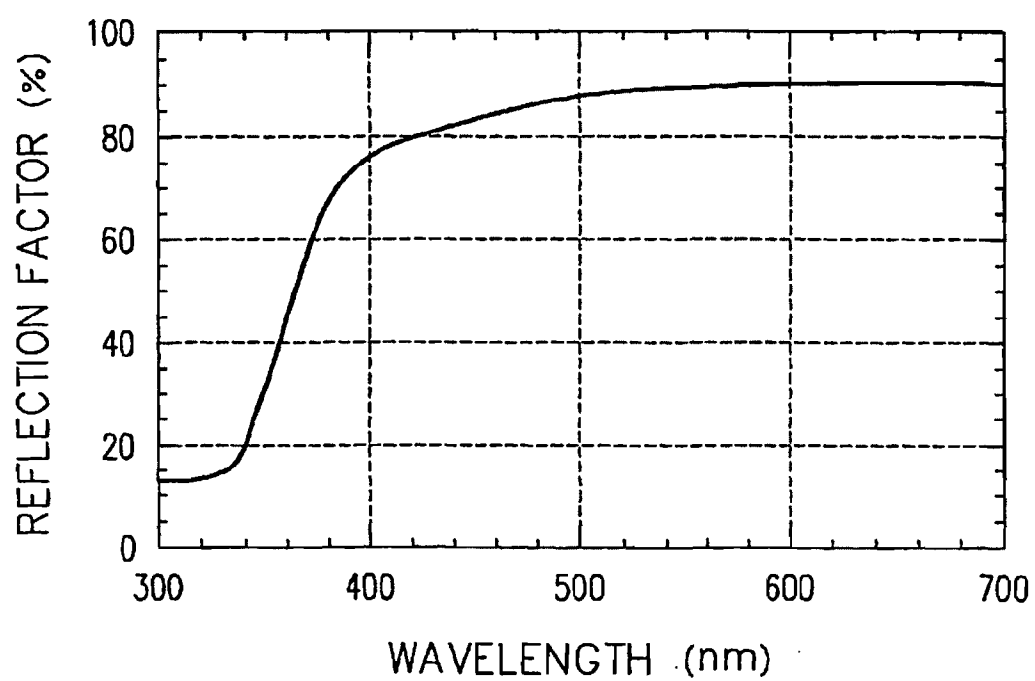


FIG. 2

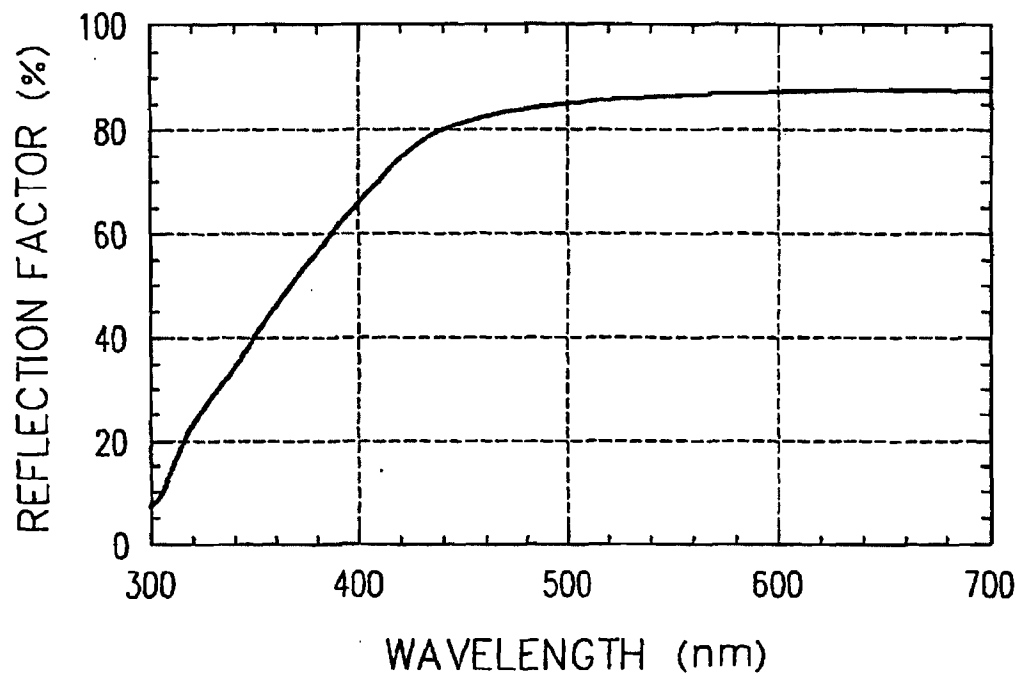


FIG. 3

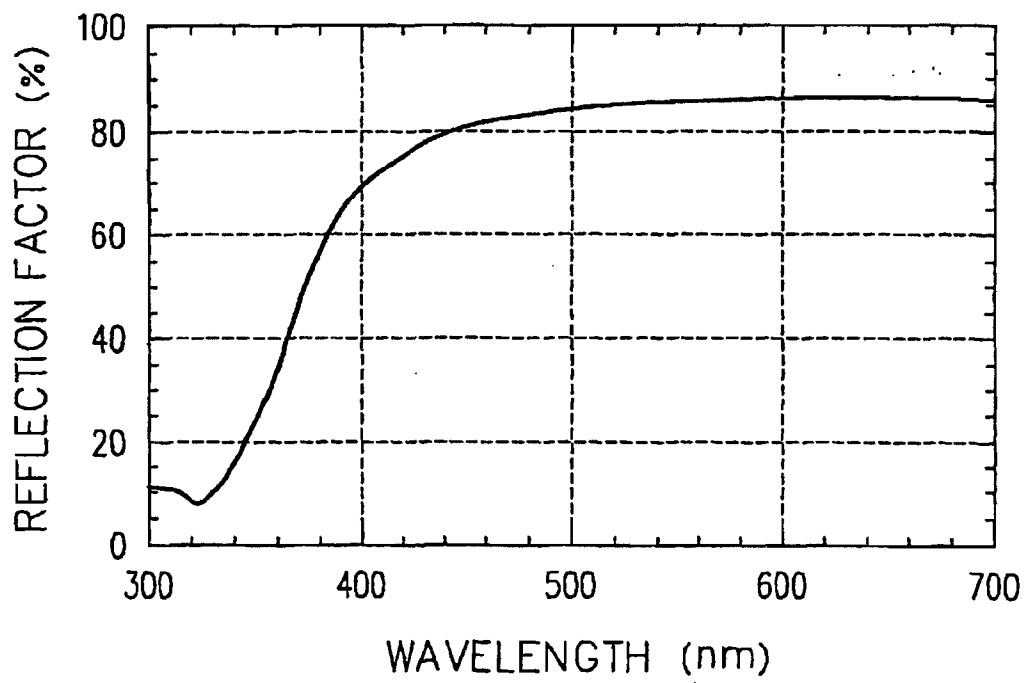


FIG. 4

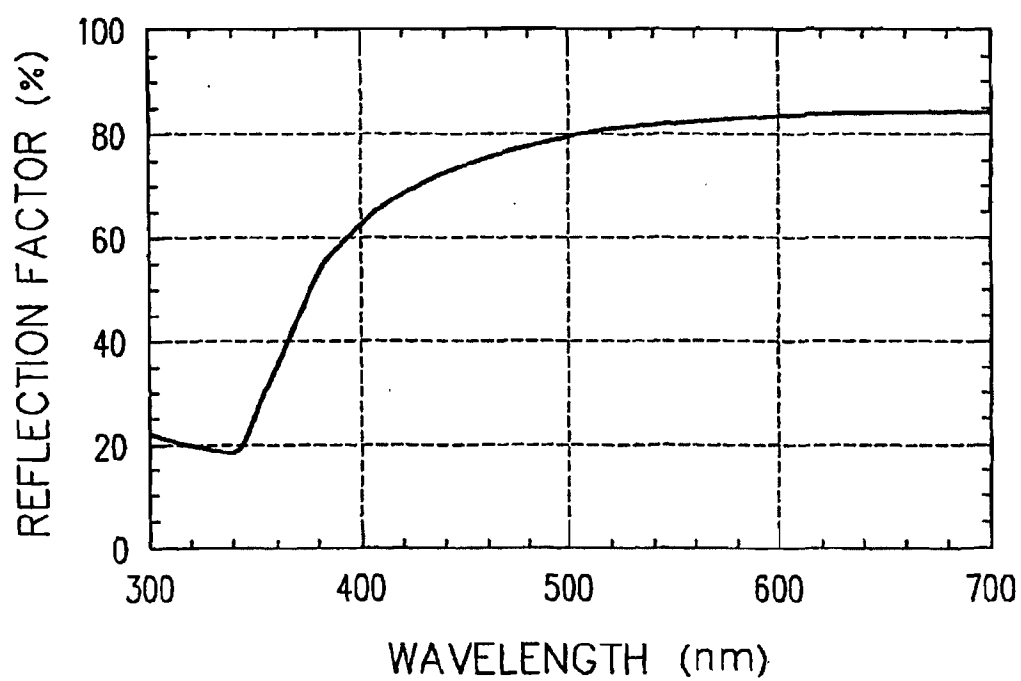


FIG. 5

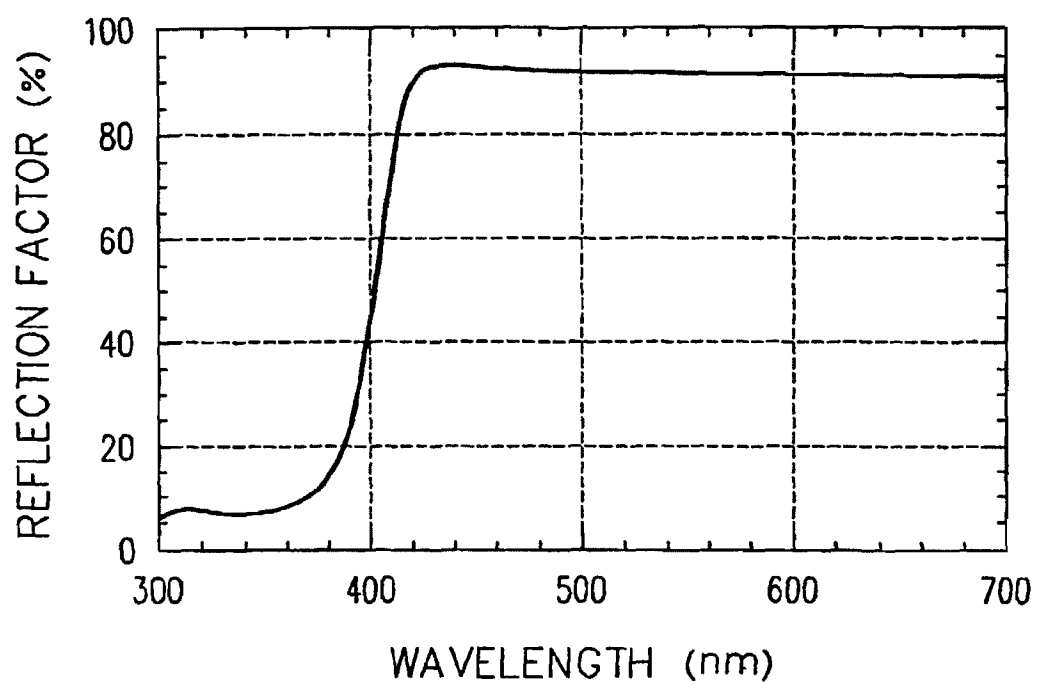


FIG. 6

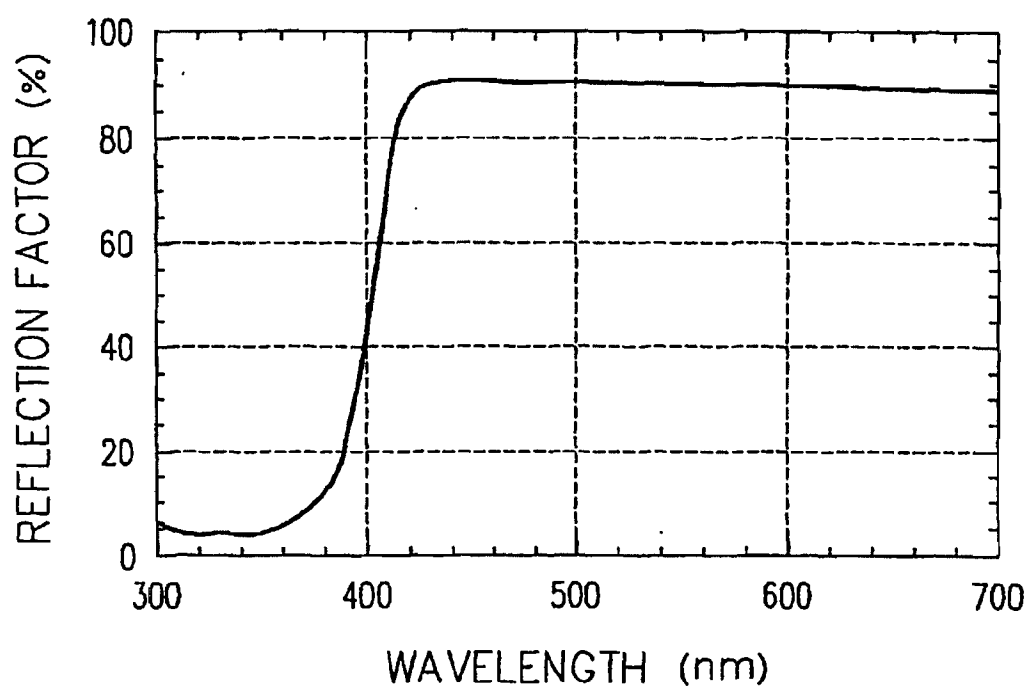


FIG. 7

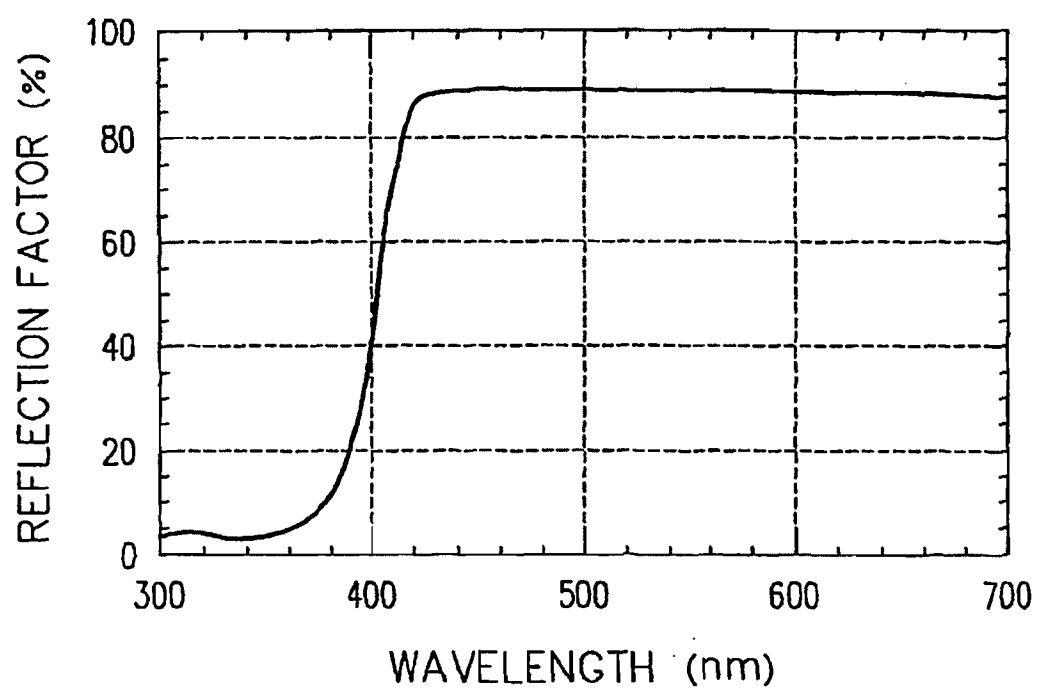
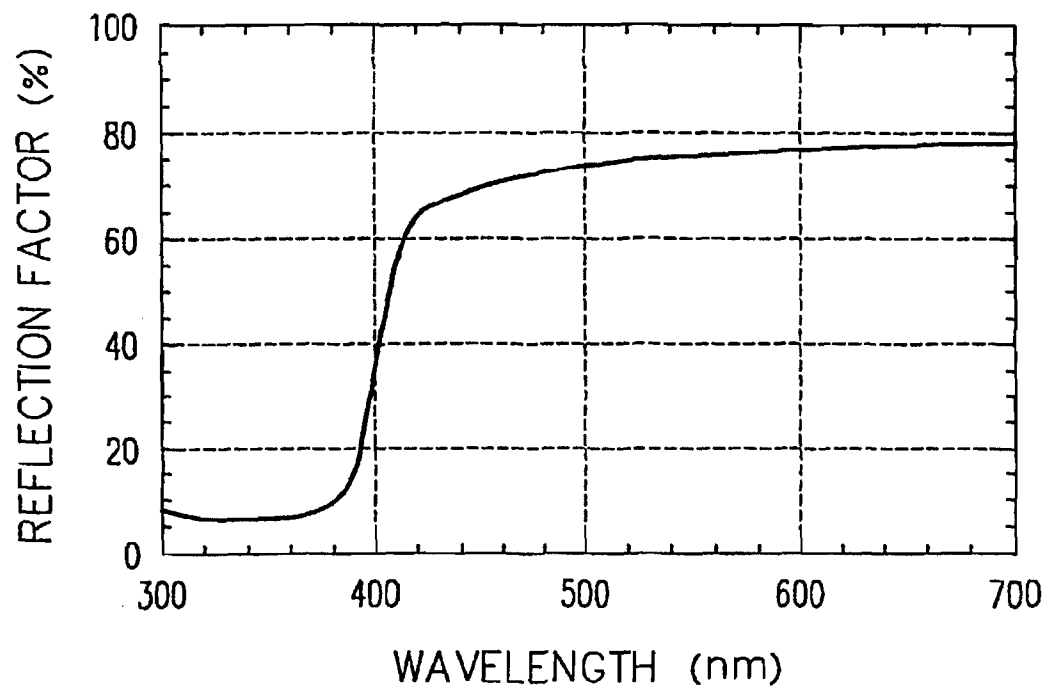


FIG. 8





## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP02/06618

## A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl<sup>7</sup> C08L77/06, C08K7/08, C08K3/34, C08L101/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl<sup>7</sup> C08L77/06, C08K7/08, C08K3/34, C08L101/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926-1996	Toroku Jitsuyo Shinan Koho	1994-2002
Kokai Jitsuyo Shinan Koho	1971-2002	Jitsuyo Shinan Toroku Koho	1996-2002

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CA (STN)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 1-168758 A (Mitsui Petrochemical Industries, Ltd.), 04 July, 1989 (04.07.89), Claims (Family: none)	1-9
X	JP 6-65500 A (Mitsubishi Gas Chemical Co., Inc.), 08 March, 1994 (08.03.94), Claims; Par. No. [0006] & EP 585056 A2 & US 5474853 A	1-9
X	JP 6-200153 A (Teijin Ltd.), 19 July, 1994 (19.07.94), Claims (Family: none)	1

☒ Further documents are listed in the continuation of Box C.☐ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search  
01 October, 2002 (01.10.02)Date of mailing of the international search report  
15 October, 2002 (15.10.02)Name and mailing address of the ISA/  
Japanese Patent Office

Authorized officer

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Telephone No.

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP02/06618

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 62-223261 A (Mitsubishi Gas Chemical Co., Inc.), 01 October, 1987 (01.10.87), Claims; page 1, lower right column, lines 10 to 19 (Family: none)	1
X	JP 5-279530 A (Idemitsu Kosan Co., Ltd.), 26 October, 1993 (26.10.93), Claims (Family: none)	4-9
X	JP 7-242810 A (Mitsubishi Gas Chemical Co., Inc.), 19 September, 1995 (19.09.95), Claims; Par. No. [0002] (Family: none)	4-7, 9
X	JP 8-41341 A (Tosoh Corp.), 13 February, 1996 (13.02.96), Claims (Family: none)	4-7, 9

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